Faucon's observations, confirmed by those of all the other persons who have made positive investigations for themselves, have established that—

1. The number of insects on a plant is in direct and constant accordance with the state of the roots.

2. According as the state of the roots is healthier, is the number of insects greater.

3. The number diminishes in proportion to the exhaustion and consequent death of the roots.

4. On an absolutely dead plant it is impossible to discover a single insect. Surely, therefore, the *Phylloxera* is the cause, and the only cause, of the vine-disease, since its appearance invariably precedes the rotting of the roots, and never follows on their decay.

We postpone till next week the description of the *Phylloxera* itself and the manner in which it attacks and ultimately kills the vine, together with the mention of the various means which have been proposed for the extirpation of the disease.

(*To be continued.*)

PHYSICS AT THE UNIVERSITY OF LONDON*

AT the present time, when the bulk of the educated population of many countries may be divided into the three classes of *Examinandi*, *Examinati*, and *Examinatores*, a large part of any discussion of what is called the higher education must inevitably be devoted to the question of examinations. Usually, if the matter is discussed from the point of view of those whose business it is to teach, the result is the condemnation of examinations in general as unfavourable to all thorough study; and, from whatever quarter the discussion proceeds, it seems to be taken for granted that the functions of the teacher and those of the examiner are naturally opposed to each other. And indeed no one who has given any attention to the question can doubt but that such an opposition really does exist in very many cases. Originally employed by teachers themselves to consolidate and test the results of their instruction, examinations were at first a natural part of the educational system; but of late years they have rapidly developed into an independent species, which has separated off from the parent organism and now too often tyrannises over it. As of other developments, so of this, we are bound to believe that it is an adaptation to co-existing conditions, and therefore fulfils some useful purposes; but, from the teacher's point of view, as soon as examinations become detached from instruction, and come to be the end of learning instead of a means of teaching, the evils they produce are much more apparent than these benefits. When they have no worse result, they are apt to be viewed by students as affording them an authoritative standard, independent of the judgment of their professors, by which to decide what subjects of study and what parts of these subjects are of sufficient importance to be worthy of their attention. It is therefore not to be wondered at that such examinations should be looked upon by teachers with dislike, as being hindrances and not helps to their work, or that we should hear frequent protests against their excessive multiplication.

While, however, I in general heartily sympathise with such protests, and feel strongly that the difficulty of honest and thorough teaching in my own subject is greatly increased by the regulations for those examinations which, in fairness to the students attending my lectures, I am bound not to lose sight of, it does not seem to me that the remedy for the evils complained of is to be looked for in the abolition of the present examination system. This system is no doubt defective in many ways, and we may perhaps hope that some day it will be replaced by one more accordant with sound educational principles; for the present, however, it exists, and must be recognised as one of the conditions under which our work has to be done. Practical wisdom therefore teaches that instead of trying to get rid of it, we should strive as far as possible to improve it, to lessen its faults, and to develop whatever good it may be susceptible of.

It is admitted on all hands that examinations carried on in direct connection with teaching are of great educational value, of so much value indeed that no careful teacher ever thinks of doing without them. What, therefore, in the interests of sound education, we ought to strive for, in relation to those examinations which are not connected with any system of instruction, is that they should be made, as nearly as possible, what they would be if they did form part of such a system. It is perhaps too much to expect that this should be taken as the leading principle in the case of examinations such as those, now so common in connection with various branches of the public service, which exist for the primary object, not of promoting education, but of preventing dolts and dunces from being supported at the public expense; but, besides these, there are many examinations nowadays, which, though unconnected with teaching, are professedly intended for the advancement of education. Among such examinations, those of the University of London are on many accounts the most important, and the intimate relation between them and much of our work in this College seems to me to be a sufficient reason for considering how far the influence which, through this relation, they exert upon our teaching, is beneficial or otherwise.

If any further justification be needed for discussing the educational tendency of the examinations of the University of London, beyond the general one arising from the paramount importance of the improvement of education, it may be found in the history of the University. It is doubtless known to many of my audience that the University of London was constituted, in most essential respects as it now exists, by a Royal Charter dated December 5, 1837, in order, "for the advancement of religion and morality, and the promotion of useful knowledge, to hold forth to all classes and denominations of [her Majesty's] faithful subjects, without any distinction whatsoever, an encouragement for pursuing a regular and liberal course of education." The form which this encouragement was to take was that of "ascertaining, by means of examination, the persons who have acquired proficiency in Literature, Science, and Art, by the pursuit of such course of education, and of rewarding them by Academical Degrees, as evidence of their respective attainments, and marks of honour proportioned thereto;" and it was directed that all persons should be admitted as candidates for degrees in Arts and Laws, who should produce certificates of having completed the course of instruction prescribed by the University either in *this* College or in King's College, London, or in any other such institution as might be authorised by the Crown to issue such certificates. But in 1858, the Senate of the University obtained a new charter by which they were empowered to admit candidates to the examinations for degrees in Arts, Laws, Science, and Music without requiring them to have previously pursued any prescribed course of study, or to have attended any particular place of instruction; and since that time no other qualification has been demanded of graduates of the University of London (with the exception of those who have taken degrees in Medicine) than the ability to pass the appointed examinations. I do not now propose to discuss the question whether the passing of an examination only affords as good ground for conferring academical distinction as the passing of the same examination combined with studentship at some recognised college or other educational institution; my object at present is

* Introductory Lecture delivered at the opening of the Session of the Faculties of Arts and Laws and of Science, in University College, London, on Monday, Oct. 5, 1874, by G. Carey Foster, F.R.S., Professor of Physics.

simply to draw attention to the fact that the University of London, created in order to encourage the pursuit of "a regular and liberal course of education," no longer requires candidates for degrees in Arts or in Science to pass through any collegiate course, but considers that she sufficiently fulfils her mission by devising and carrying out into practice a system of examinations. It appears to me that this fact justifies all who are interested in the progress of sound education in demanding that these examinations should be so arranged as to encourage to the utmost possible extent thorough study and conscientious teaching.

The present Regulations of the University do not in all cases seem to me to fulfil this condition as completely as they might do, and I therefore think that I may suitably make use of this opportunity for trying to point out their defects as definitely as I can, and for attempting, if possible, to suggest improvements. I need hardly say, however, that whatever criticisms or suggestions I may venture to make will refer almost exclusively to the Regulations affecting that branch of science, namely Physics, with which I am specially connected. I believe, nevertheless, that the general principles which it is of greatest importance to keep in view in framing an examination in any department of knowledge are very nearly the same, and therefore I venture to hope that if the reflections which my experience of the London University examinations, both as an Examiner and as a Teacher, has suggested to me, are of any value in relation to my own subject, they may not be quite worthless in relation to others.

In order to apply to the case of Physics the general principle that examinations and direct teaching ought to be only different ways of attaining the same object, it is needful to consider first of all what reasons there may be for including the study of Physics in "a regular and liberal course of education," and what ought therefore to be the aim of teacher and examiner alike. With regard to this point, it will probably be admitted that the educational value of the study of Physics depends upon the mental discipline which it ensures, and not upon the individual facts, or even on the general laws, with which it stores the memory. It follows from the nature of the phenomena with which this science deals, that, to a much greater extent than has hitherto been the case with the phenomena of any other branch of science, the exact conditions of their occurrence have been ascertained, and the relations which they bear to one another have been expressed by definite numerical laws. In consequence of the precision which it is hence possible to give not only to statements respecting individual physical phenomena, but also to statements involving general laws, the reasoning by which the conclusions of Physics are established assumes a stricter character than can be attained in any other branch of natural science. It may be confidently asserted that, for training the mind in habits of accurate thinking, no other study can be compared with that of Physics if properly pursued; for, while it affords abundant practice in deductive reasoning of mathematical strictness, it obliges us to give no less attention to the converse process of inferring general laws from particular concrete phenomena and the direct impressions which they make on our senses. It is this combination of deductive with inductive reasoning which constitutes the special value of the study of Physics for the purposes of mental discipline. It is quite true that the deductive processes of Physics are borrowed from Mathematics, and that it shares the inductive method with all the other branches of natural science; but the greater definiteness of physical phenomena, as compared with those of other sciences, not only, as I have already said, leads to a greater definiteness in our general conclusions respecting them, but, as a further consequence, makes it easier to test the truth or falsehood of their conclusions by comparing the results deductively derived from them with the results of new experiments or observations. It may even, indeed, be thought that the comparative definiteness and precision of the problems with which the science of Physics is concerned render the study of it less serviceable, as a preparation for dealing with the complex questions which arise in the common experience of life, than the study of sciences in which the uncertainty and indefiniteness of the data leave a greater scope for the exercise of a judicious tact in the estimation of probabilities; but to maintain such an opinion would be very much like saying that in order to become familiar with the laws of chemical action and the nature of chemical combination, we ought to study the transformations of albumen and chlorophyll rather than the properties of such things as potassium, oxygen, or sulphuric acid. It is of course because physical phenomena are simpler and more accessible to investigation than those of Chemistry or Biology, that greater progress has been made in the study of them, and that the explanations that have been reached are of a higher degree of certainty and generality; but it is precisely the relatively advanced stage which has been reached by it that gives to the study of Physics its high value as an element in general education, and is the reason why it furnishes us with fuller and more instructive examples of scientific reasoning than other sciences.

The nature of the intellectual benefits that have been pointed out as resulting from this study, suggests at once the conditions that must be fulfilled in order to obtain them. If in studying Physics we really undergo, as I have said, a process of training to think correctly, this can only be through the exercise of our minds in following the demonstrably correct trains of thought whereby the general conclusions of Physics have been derived from the observed facts, and through our becoming so familiar with them that, consciously or unconsciously, we take them for our models, whatever may be the subjects to which we require to direct our minds. It follows from this that these benefits do not depend upon the direct results of experiment or observation with which the study makes us acquainted, nor upon the general laws of nature which it reveals to us, but upon the reasoning processes whereby facts and laws are connected together and both are made part of the living body of science. And from this again we see that the kind of teaching and study to be aimed at is that which enables us to trace these processes step by step and to understand their validity; while the kind to be anxiously avoided is that which stores the memory with detached pieces of information, either in the form of facts whose mutual relations are not perceived, or in the form of theoretical conclusions hung up between heaven and earth, and supported neither by revelation from above nor by demonstration from below. This latter, however, is the kind of teaching so much in demand and so frequently offered, which is known by the name of "cramming."

By way of guarding against misconception, it may be well to point out—what, however, is exceedingly obvious—that there can be no reasoning about Physics until the facts of Physics are known, and therefore that the teaching of these facts must always occupy an important place as the indispensable groundwork of all that is to follow. But still it must be remembered that, so long as we are considering the study of Physics merely as a part of general education, the facts of the science are of importance only in relation to the reasoning that is based upon them. Taken by itself, one bit of information is of about as little use in developing the mental powers as any other; it does us about as much good to be told that "heat is a mode of motion" as that "the Government of England is a limited monarchy," and to know the difference between a thermometer and a barometer enlarges the mind to about the same extent as to know how to distinguish a pitchfork from a Dutch hoe.

We may now return to consider the effect of the examinations of the University of London upon the teaching of Physics. These examinations, as we have seen, exist for the express purpose of encouraging the pursuit of "a regular and liberal course of education," or, as it may be otherwise expressed, in order to encourage good teaching and to discourage bad; and in the foregoing remarks I have tried to show as definitely as I can what meaning is to be attached to the words "good" and "bad" in relation to the teaching of Physics. The obvious conclusion, applicable to the particular point to which I now wish to ask your attention, is that examinations are to be regarded as *good* if they induce candidates to *think* about the mutual relations of individual facts and their connection with general principles; while examinations are *bad* in proportion as they lead to the loading of the memory with unconnected scraps of knowledge.

There are two ways in which the examinations of the University of London tend to affect the quality of teaching for good or for evil: first, by the general Regulations drawn up by the Senate in reference to the various examinations, including the list of subjects to be taken up and the specifications of the requirements in each subject; and secondly, the questions set by the Examiners, which form as it were a detailed commentary, authorised by the Senate, on the meaning of their own Regulations. For various reasons, the lowest examinations, or those which come earliest in the University scheme, produce the greatest effect on methods of teaching and learning; for one thing, they affect the greatest number of candidates, and they come at a part of the candidates' career when they are most dependent on external authority or advice as to the course of their studies.

THE BIBLIOGRAPHY OF SCIENCE

THERE can be no surer indication of the universal spread of science during the last few years than the large and annually increasing number of works relating to its various branches that are advertised for publication during each successive season. The considerable element which science now forms in education, in the arts and manufactures, in commerce and agriculture, and in the social economy of life, renders the knowledge of at least its rudiments absolutely necessary in almost every sphere of existence. The particulars given below will show that publishers are fully alive to the importance and value of good works in this department of literature.

Although even now we have a large quantity of educational books of varying degrees of mediocrity and excellence in almost all the commoner branches of science, and the number of works is ever increasing, yet the advance made by science makes it imperative that fresh manuals and class-books and new editions should be continually published, in order that students and workers should be enabled to keep pace with its rapid strides. The works we notice beneath range from the smallest general primer to the most elaborated and matured works in particular and specific branches of science; and among them will be found books by men of the highest reputation in their special provinces. We have endeavoured to notice every work of importance which is to be published during the next few months; but our list is necessarily incomplete; we shall, however, in future numbers note any deficiencies, omissions, or fresh announcements.

In ASTRONOMY we observe the following books:—*The Moon*, and the Condition and Configuration of its Surface, by Edmund Neison, Fellow of the Royal Astronomical Society, &c., illustrated by maps and plates. (Longmans.)—*A Primer of Astronomy*, by J. Norman Lockyer, F.R.S., with illustrations. (Macmillan.)—A new edition of *Navigation and Nautical Astronomy*, in theory and practice, by Prof. J. R. Young. (Lockwood.)—*The Transits of Venus*, a Popular Account of Past and Coming Transits, from the first observed by Horrocks, A.D. 1639, to the Transit of A.D. 2112, by Richard Anthony Proctor, B.A. Cantab., Hon. Fell. King's Coll. Lond., with twenty plates and numerous woodcut illustrations. (Longmans.)

In CHEMISTRY we are promised a new edition of *Dr. Normandy's Commercial Handbook of Chemical Analysis*, enlarged and almost re-written by Dr. H. M. Noad, Ph.D., F.R.S. &c., with numerous illustrations. (Lockwood).—A second edition of *Plattner's Manual of Qualitative and Quantitative Analysis with the Blowpipe*, from the last German edition, revised and enlarged by Prof. Th. Richter, of the Royal Saxon Mining Academy, translated by Prof. H. B. Cornwall, Assistant in the Columbia School of Mines, New York; this work is illustrated with eighty-seven woodcuts and one lithographic plate. (Sampson Low.)—*Industrial Chemistry*, a Manual for Manufacturers and for use in Colleges or Technical Schools, being a translation by Dr. J. D. Barry, of Professors Stohmann and Engler's German edition of Payen's "Précis de Chimie Industrielle;" edited throughout and supplemented with chapters on the Chemistry of the Metals, by B. H. Paul, Ph.D., with very numerous plates and woodcuts. (Longmans.)—A third enlarged edition of *A Systematic Handbook of Volumetric Analysis*, or the Quantitative Estimation of Chemical Substances by Measure, applied to Liquids, Solids, and Gases, with numerous engravings, by Francis Sutton, F.C.S., Norwich. (Churchill.)—*The Chemical Effects of Light and Photography, in their Application to Art, Science, and Industry*, by Dr. Hermann Vogel. (King and Co.)—A new edition, revised and enlarged, of *Practical Metallurgy*, by John Percy, M.D., F.R.S., Lecturer on Metallurgy at the Government School of Mines. Vol. I., Part 1. Introduction; Fuel, wood, peat, coal, charcoal, coke, refractory materials, fire-clays, &c. Vol. I., Part 2. Copper, zinc, brass. (John Murray.)

In PHYSICS and MECHANICS, Messrs. Longmans will publish the three following books:—*The Elements of Physics*, by Neil Arnott, M.D., F.R.S., the seventh edition, revised from the author's notes and other sources, and edited by Alexander Bain, LL.D., Professor of Logic in the University of Aberdeen, and by Alfred Swaine Taylor, M.D., F.R.S., Professor of Medical Jurisprudence, Guy's Hospital.—*Introduction to Experimental Physics, Theoretical and Practical*, including directions for constructing physical apparatus and for making experiments, by Adolf F. Weinhold, Professor in the Royal Technical School at Chemnitz, translated and edited (with the author's sanction) by Benjamin Loewy, F.R.A.S, with a preface by G. C. Foster, F.R.S., Professor of Physics in University College, London, with numerous wood engravings.—*Lessons in Elementary Mechanics*, introductory to the Study of Physical Science, by Philip Magnus, B.Sc., B.A. This book is adapted to the requirements of the London Matriculation, Preliminary, Scientific, First M.B., and other Examinations.

Messrs. Charles Griffin will issue *A Mechanical Text-Book*, a Practical and Simple Introduction to the Study of Mechanics, by William John Macquorn Rankine, C.E., LL.D., F.R.SS., &c., late Regius Professor of Civil Engineering in the University of Glasgow; and Edward Fisher Bamber, C.E.

In BIOLOGY we have a large number of new books and new editions, of which the following are the most noteworthy:—*The History of Creation*, by Prof. Ernst Haeckel, the translation revised by E. Ray Lankester, M.A. (King and Co.)—*Elements of Human Physiology*, by Dr. L. Hermann, Professor of Physiology in the University of Zurich, translated and edited from the sixth (yet unpublished) German edition, at the author's request, by Arthur Gamgee, M.D., F.R.S., Brackenbury